ft6188

SPI-Controlled Dual SIM Card Controller(Rev.1.1)

General Description

Fangtek's ft6188 is a SIM card control device designed for dual SIM card enabled mobile phones. The ft6188 supports both 1.8V and 3.3V SIM cards with integrated LDOs and level shifters. A Serial Port Interface (SPI) is used to configure and control the both cards.

The ft6188 works as a SIM card switch to bring card to operation in turns at specified interval. The device adopts a break-before-make switching scheme, i.e., to break the connection with a card before getting connected with the other so as to avoid possible communication collision.

The ft6188 features the internal LDO and level shifter to support both 1.8V and 3.3V cards and thus provides a universal SIM card interface.

The ft6188 SPI control interface is designed to communicate with microprocessors or controllers, such as cell phone baseband chip. The three-line interface provides easy access with the universal data communication standards, as well as saves the GPIO communication pins which are precious resource on microprocessors.

The ft6188 is available in 3mm x 3mm QFN20 package, 0.4mm pitch.

Key Specifications

- Supply Range: 2.7V to 5.5V
- $I_{BAT(SD)}$: 0.1μA
- 1.8V Mode Output Range: 1.65V to 1.95V
- 3.3V Mode Output Range: 2.82V to 3.18V
- Maximum Output Current: 38mA (typical)
- Turn-on Time: 0.8ms (typical); 1.5ms (max.)
- Packaging: QFN-20 (3mm x 3mm; 0.4mm pitch)

Applications

- Dual SIM card mobile phone
- Smartphone

Application Circuit

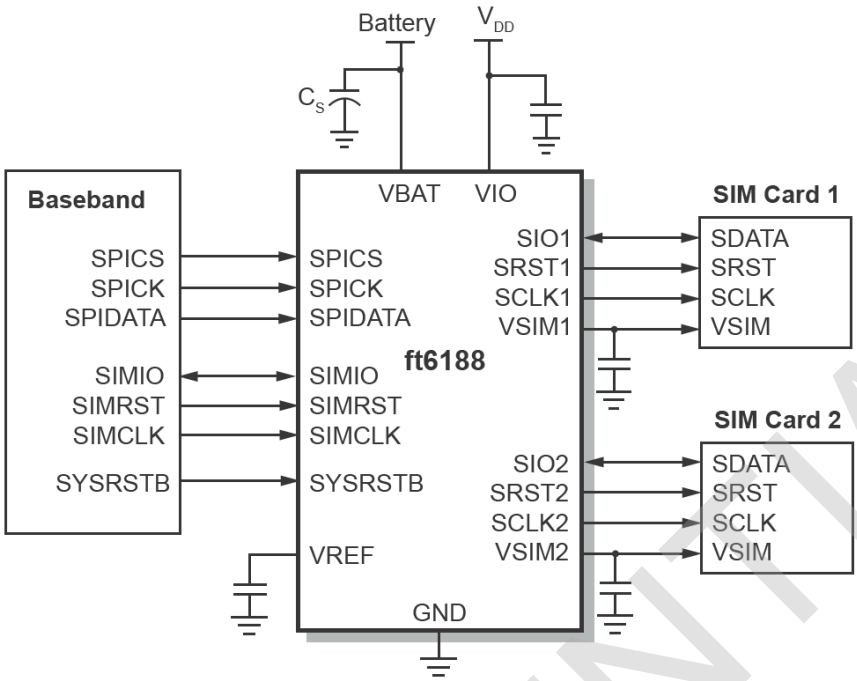


Figure 1.Typical Application Circuit

Ordering Information

P/N	TEMP RANGE	PIN-PACKAGE
ft6188	-25°C to +85°C	20pin QFN

Absolute Maximum Ratings

Supply Voltage (V_{SS})	-0.3V to 7V
Input Voltage (V_I)	-0.3V to V_{DD} +0.3V
Maximum Junction Temperature	+150°C

Operation Ratings

Supply Voltage (V_{SS})	2.5V to 5.5V
Operating Temperature (T_A)	-25°C to +85°C
Storage Temperature (T_{STG})	-65°C to +150°C

Electrical Characteristics

Note: The following electrical characteristics state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. But note that specifications are not guaranteed for parameters where no limit is given. The typical value however, is a good indication of device performance.

All voltages in the following tables are specified at 25°C which is generally taken as parametric norm.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
Input Power Supply						
V_{BAT}	Battery supply voltage		2.7		5.5	V
I_{BAT_SD}	Battery supply shutdown current	V_{IO} = 0V		0.1	1	μA
I_{BAT}	Battery supply operating current	VSIM1 = 3.0V, VSIM2 = 0V, no load VSIM1 = 1.8V, VSIM2 = 0V, no load		30	70	μA
V_{IO}	Device supply voltage		2.6		3.3	V
I_{IO_SD}	Device supply shutdown current			0.1	1	μA
I_{IO}	Device supply operating current			3	10	μA
SPI Input						
V_{IL}	Input level low	SPIDATA, SPICK, SPICS, SYSRST			0.15*V_{IO}	V
V_{IH}	Input level high	SPIDATA, SPICK, SPICS, SYSRST	0.85*V_{IO}			V
SIM Card Supply						
	1.8V output voltage		1.65	1.8	1.95	V
	3.0V output voltage		2.82	3.0	3.18	V
I_{SHORT}	Output short current limit			40		mA
	Load regulation (1.8V)	0.05mA < ILOAD < 20mA @ VBAT = 3.6V		1	10	mV
	Load regulation (3.0V)	0.05mA < ILOAD < 20mA @ VBAT = 3.6V		1.7	10	mV
t_{ON}	Turn on time	No load. Enable VSIM1,2 at 90% specified voltage		0.8	1.5	ms
GSM Interface						
VSIMCLK_IH VSIMRST_IH	SIMCLK, SIMRST input level high		V_{IO} - 0.6			V
VSIMCLK_IL VSIMRST_IL	SIMCLK, SIMRST input level low				0.6	V
VSIMIO_IL	SIMIO input level low	VOL ≤ 0.4V, IOL = 1mA			0.23	V
		VOL ≤ 0.4V, IOL = 0mA			0.335	V
VSIMIO_IH VSIMIO_OH	SIMIO input and output level high	IIH, IOH = ± 20μA	V_{IO} - 0.6			V
I_{SIMIO_IL}	SIMIO input low current	V_{IL} = 0V			-0.9	mA
V_{SIMIO_OL}	SIMIO output low level	V_{IL} = 0.4V			0.42	V
Interface to 3V SIM Card						
V_{SRST_OL}	SRST output low level	Sink current = -20μA (VSIMRST = 0.6V)			0.4	V
V_{SRST_OH}	SRST output high level	Source current = 200μA (VSIMSRT = VIO - 0.6V	0.9*V_{SIM}			V
V_{SCLK_OL}	SCLK output low level	Sink current = -20μA (VSIMCLK = 0.6V)			0.4	V
V_{SCLK_OH}	SCLK output high level	Source current = 200μA (VSIMCLK = VIO - 0.6V	0.9*V_{SIM}			V
V_{SIO_IL}	SIO input low level				0.15*V_{SIM}	V
V_{SIO_IH} V_{SIO_OH}	SIO input high level, SIO output high level	Source current = 20μA	V_{SIM} - 0.4			V
I_{SIO_IL}	SIO input low level current	V_{SIO} = 0V			-1	mA

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{SIO_OL}	SIO output low level	Sink current = -1mA (V_{SIMIO} = 0V)			0.15*V_{SIM}	V
Interface to 1.8V SIM Card						
V_{SRST_OL}	SRST output low level	Sink current = -20μA (VSIMRST = 0.6V)			0.2*V_{SIM}	V
V_{SRST_OH}	SRST output high level	Source surrent = 200μA (VSIMSRT = VIO - 0.6V	0.9*V_{SIM}			V
V_{SCLK_OL}	SCLK output low level	Sink current = -20μA (V_{SIMCLK} = 0.6V)			0.2*V_{SIM}	V
V_{SCLK_OH}	SCLK output high level	Source surrent = 200μA (VSIMCLK = VIO - 0.6V	0.9*V_{SIM}			V
V_{SIO_IL}	SIO input low level				0.15*V_{SIM}	V
V_{SIO_IH} V_{SIO_OH}	SIO input high level, SIO output high level	Source current = 20μA	V_{SIM} - 0.4			V
I_{SIO_IL}	SIO input low level current	V_{SIO} = 0V			-1	mA
V_{SIO_OL}	SIO output low level	Sink current = -1mA (V_{SIMIO} = 0V)			0.15*V_{SIM}	V
SIM Card Interface Timing						
t_{SRST} t_{SIO}	SRST, SIO rise/fall time	VSIM = 3V and 1.8V, loaded with 30pF (10%~ 90%)			1	μs
t_{SCLK}	SCLK rise/fall time	VSIM = 3V, loaded with 30pF (10%~ 90%)			18	ns
		VSIM = 1.8V, loaded with 30pF (10%~ 90%)			50	ns
f_{SIMCLK}	SCLK frequency		5			MHz
	SCLK duty cycle	SIMCLK duty = 50%, f_{SIMCLK} = 5MHz	47		53	%
	SCLK propagation delay	From SIMCLK to SCLK		25	50	ns

Pin Description

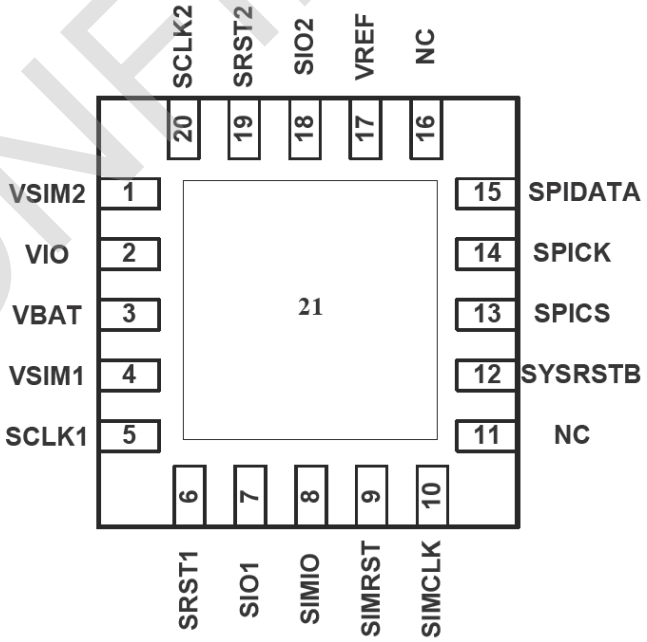


Figure 2 ft6188 QFN-20 Top View

Pin	Name	Function
1	VSIM2	SIM2 Supply
2	VIO	Digital IO Supply
3	VBAT	Battery Input Voltage
4	VSIM1	SIM1 Supply
5	SCLK1	Level-Shifted SIM1 Clock Output
6	SRST1	Level-Shifted SIM1 Reset Output
7	SIO1	Level-Shifted SIM1 Bidirectional Data Input/Output
8	SIMIO	Non-Level-Shifted Bidirectional Data I/O
9	SIMRST	Non-Level-Shifted SIM Reset Input, Internal Pull High to VIO
10	SIMCLK	Non-Level-Shifted SIM Clock Input
11	NC	
12	/SYSRSTB	System Reset, Low Active
13	SPICS	Serial bus selection
14	SPICK	Serial bus clock
15	SPIDATA	Serial bus data
16	NC	
17	VREF	Reference Voltage Output
18	SIO2	Level-Shifted SIM2 Bidirectional Data Input/Output
19	SRST2	Level-Shifted SIM2 Reset Output
20	SCLK2	Level-Shifted SIM2 Clock Output
21	GND	Ground

Serial Port Interface (SPI)

The Serial Port Interface (SPI) of the ft6188 is for receive commands from the microcontroller, or baseband chip in mobile phone. The SPI is an 8-bit wide interface with 3 bits allocated for address information and the 5 for data contents. Three pins, $\overline{\text{SPICS}}$, SPIDATA, and SPICK, are used for chip select, data transmission and clock input respectively.

Timings of the ft6188 SPI interface are illustrated in the Figure 3. When SPI is set idle, the $\overline{\text{SPICS}}$ pin is pulled high and SPICK is pulled low. When SPI is enabled to write to the device, $\overline{\text{SPICS}}$ is pulled low and remains low during the whole course of data transmission. When 8-bit data write is complete, the $\overline{\text{SPICS}}$ is again pulled high.

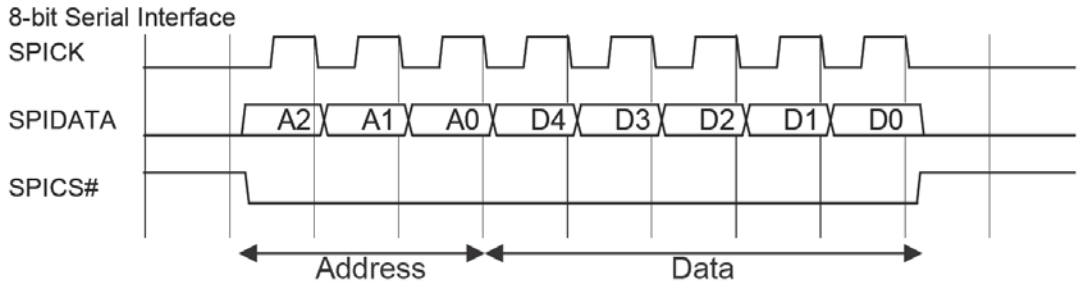


Figure 3 SPI Interface Date Transmission Timings

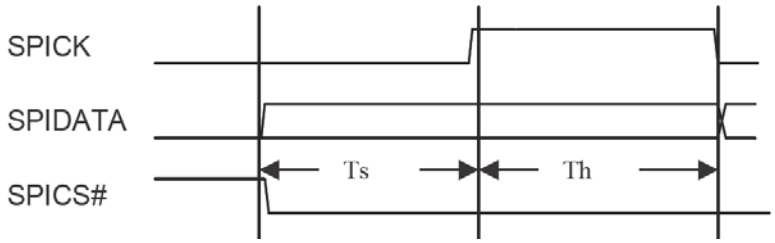


Figure 4 SPI Interface Timing Diagram

Serial Port Interface Timing

Symbol	Parameter	Min	Typ	Max	Unit
Ts	SPIDATA to SPICK setup time	4			ns
Th	SPIDATA to SPICK hold time	4			ns

Register Definitions

Name: Reset Control Register

Address: 0000H

Description: The LSB bits of the signals are for SIM card1; the MSB are for SIM card 2.

Bit	Name	Access	Description	Reset
4	-		Reserved	-
3	RSTVAL	WO	Control the value of SIM card RST pin. Valid only when VCCEN and RSTSEL are set to 1. 0 = Force the SIM card RST pin to 0. 1 = Force the SIM card RST pin to 1.	0
2				0
1	RSTSEL	WO	SIM card RST pin control. Valid only when VCCN is set to 1. 0 = The RST pin of the SIM card is the same with SIMRST input. 1 = The RST pin of the SIM card is controlled by SRTVAL	0
0				0

Name: Clock Control Register

Address: 0001H

Description: The LSB of these two signals is for SIM card1, and MSB is for SIM card2. The value of SIM card CLK pin is controlled by the combination of the two signals when VCCEN is 1.

Bit	Name	Access	Description	Reset
4	-		Reserved	-
3	CPOH	WO	Bit 0 and 2 are for SIM card 1; bit 1 and 3 are for SIM card 2. CPOH =0, CPOL =1: the CLK pin of the SIM card is the same as the SIMCLK pin. CPOH =1, CPOL =1: force the SIM card CLK pin to stop at high. CPOH =0, CPOL =0: force the SIM card CLK pin to stop at low CPOH =1, CPOL =0: Not allowed	0
2				0
1	CPOL	WO		1
0				1

Name: **Data Control Register**

Address: 0002H

Description: The LSB of these two signals is for SIM card1, and MSB is for SIM card2.

Bit	Name	Access	Description	Reset
4	-		Reserved	-
3	DATA_L	WO	Control the value of SIM card DATA pin, only valid when both VCCEN and DATAEN are '1'. 0 = normal function. 1 = Force the SIM card DATA pin to 0.	0
2				0
1	DATAEN	WO	SIM card DATA pin control, only valid when VCCEN is 1. 0 = the channel between SIM card DATA pin and ft6188 I/O pin SIMDATA will be gapped. If there were no drivers of these two pins, then they will be pulled high. 1 = The channel between SIM card DATA pin and ft6188 I/O pin SIMDATA will be opened. If there were no drivers of these two pins, then they will be pulled high.	1
0				1

Name: **VCC Control Register**

Address: 0003H

Description: The LSB of these two signals is for SIM card1, and MSB is for SIM card2.

Bit	Name	Access	Description	Reset
4	-		Reserved	-
3	VCCEN	WO	SIM card power control.. 0 = Turn off SIM card VCC pin, all signals to SIM card will be 0. 1 = Turn on SIM card VCC pin.	0
2				0
1	VSEL	WO	Choose the supply voltage level of SIM card. 0 = Supply voltage is 1.8V. 1 = Supply voltage is 3V.	0
0				0

Name: **LDO Reference Selection**

Address: 0004H

Bit	Name	Access	Description	Reset
4	REFSEL	WO	LDO reference selection 0 = VIO 1 = bandgap	0
3	-	-	Reserved	-
2				
1				
0				

Name: **Bandgap Control Register**

Address: 0005H

Bit	Name	Access	Description	Reset
4	BG_EN	WO	Embedded bandgap enable 0 = disable 1 = enable	-
3	RBGSEL	WO	Bandgap T.C. fine turning. 00 = initial setting 01 = minus 1 step 10 = plus 1 step 11 = plus 2 step	0
2				0
1	-	-	Reserved	-
0				

Signal Processing Blocks

The main function of this block is to handle the command ordered by baseband processor about SCLK and SRST. When it receives commands sent by SPI, it will do the corresponding signal processing, and then sent the results to analog blocks. The commands is transmitted through serial port interface (SPI) and stored in the register set. Signal processing blocks will process signals with corresponding commands. The truth table of SCLK and SRST is shown in the following tables.

VSIM	CPOH	CPOL	SIMCLK	SCLK
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	Not allowed
1	1	0	1	Not allowed
1	1	1	0	1
1	1	1	1	1

Table 1. Truth table of SCLK

VSIM	RSTSEL	RSETVAL	SIMRST	SRST
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	0
1	1	1	0	1
1	1	1	1	1

Table 2. Truth table of SRST

It will be noticed that the effect of those controlled signal may not be valid immediately due to the delay of some processing time.

Analog Blocks

This module contains SIM LDO, level shifter and bandgap function. It will accept the command set by SPI and also transfer the signals to suitable voltage level to SIM cards. The SIM LDO is a regulator that could source 20mA (max) with 1.8V or 3.0V output voltage selection based on the supply specs of subscriber identity modules (SIM) card.

SIM Card Interface

The SIM card interface circuitry of ft6188 meets all ETSI and IMT-2000 SIM interface requirements. It provides level shifting needs for low voltage GSM controller to communicate with either 1.8V or 3V SIM cards. All SIM cards contain a clock input, a reset input, and a bi-directional data input/output.

Card Activation and Deactivation

The role of ft6188 at card activation and deactivation is just a signal bypasser. It will bypass SIMCLK and SIMRST transmitted by baseband processor and turn on the channel between SIMIO and SIO.

When card activation, user just needs to follow the steps listed below.

- Set VSEL to desired level.
- Turn on VCCEN and DATAEN in sequence, and the other registers just keep their default settings.
- Turn on SIM interface of baseband processor to start activation sequence.

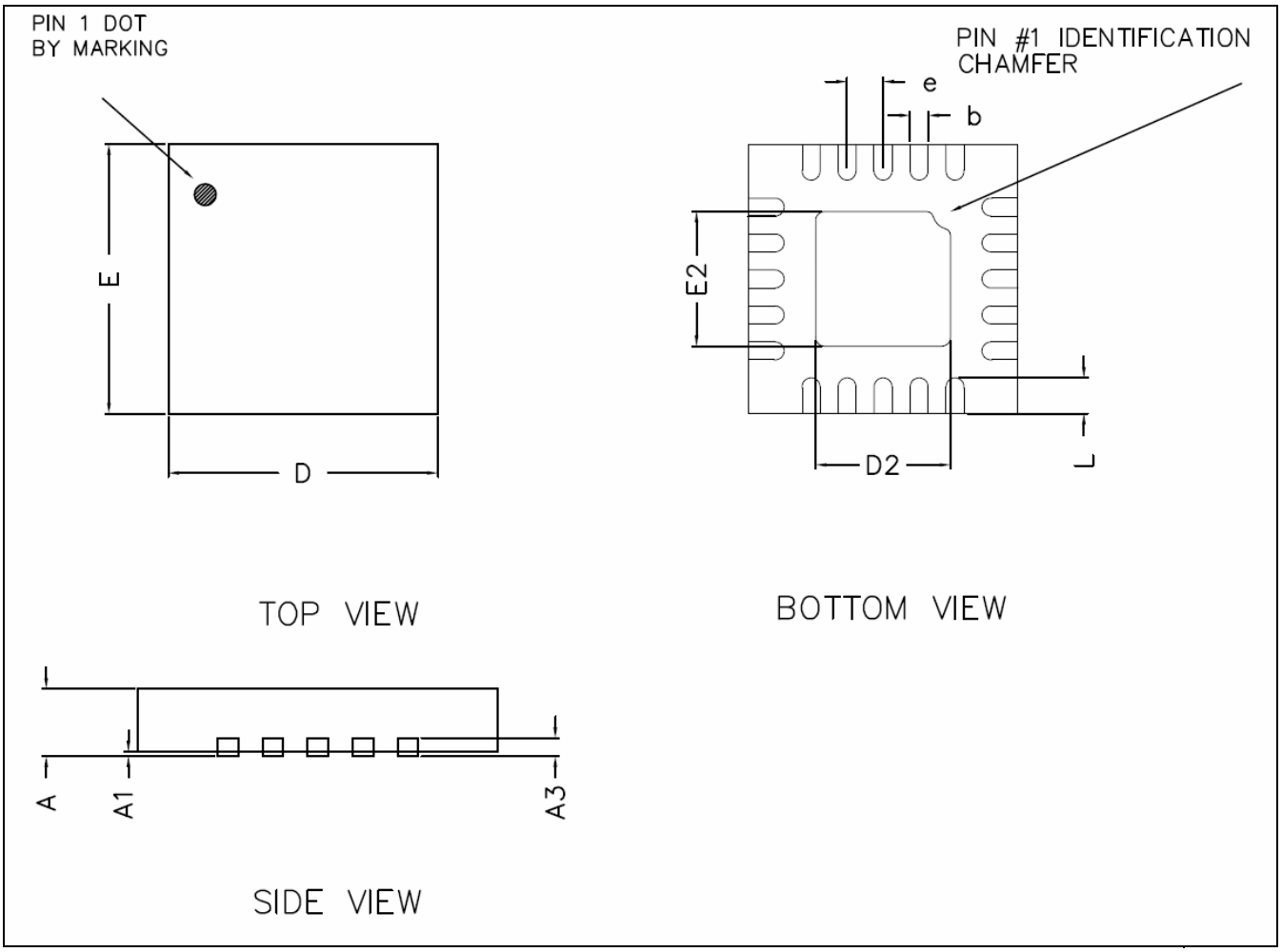
Similarly, when card deactivation, user just follows the steps listed below.

- Turn off SIM interface of baseband processor to start deactivation sequence.
- Set DATA_L and then turn off VCCEN, and the other registers just keep their default settings.

Mechanical Data

Notes*:All Dimensions are in millimeters.

QFN-20



COMMON DIMENSIONS(MM)			
PKG	W:VERY VERY THIN		
REF	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	--	0.05
A3	0.2 REF.		
D	2.95	3.00	3.05
E	2.95	3.00	3.05
b	0.15	0.20	0.25
L	0.30	0.40	0.50
D2	1.35	1.50	1.60
E2	1.35	1.50	1.60
e	0.4BSC		

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